

# Benefit-Cost Analysis 101

Introduction to Information Needed to Complete a BCA and Potential Sources of Documentation

*February 2022*



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# Purpose of BCA 101 Webinar

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- Introduce the FEMA benefit-cost analysis (BCA) and its purpose
- Identify what information is needed to complete a BCA using FEMA's BCA Toolkit
- Identify where/how to obtain this information





# Agenda

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- Introduction
  - What is a BCA and why is it needed?
- Components of a BCA
  - What kind of information is needed to complete a BCA?
- Documenting the BCA for all projects
  - What documentation do you need for the BCA and what are some potential sources?
    - Best practices for all projects
    - Basic documentation needed for all projects
- Q&A



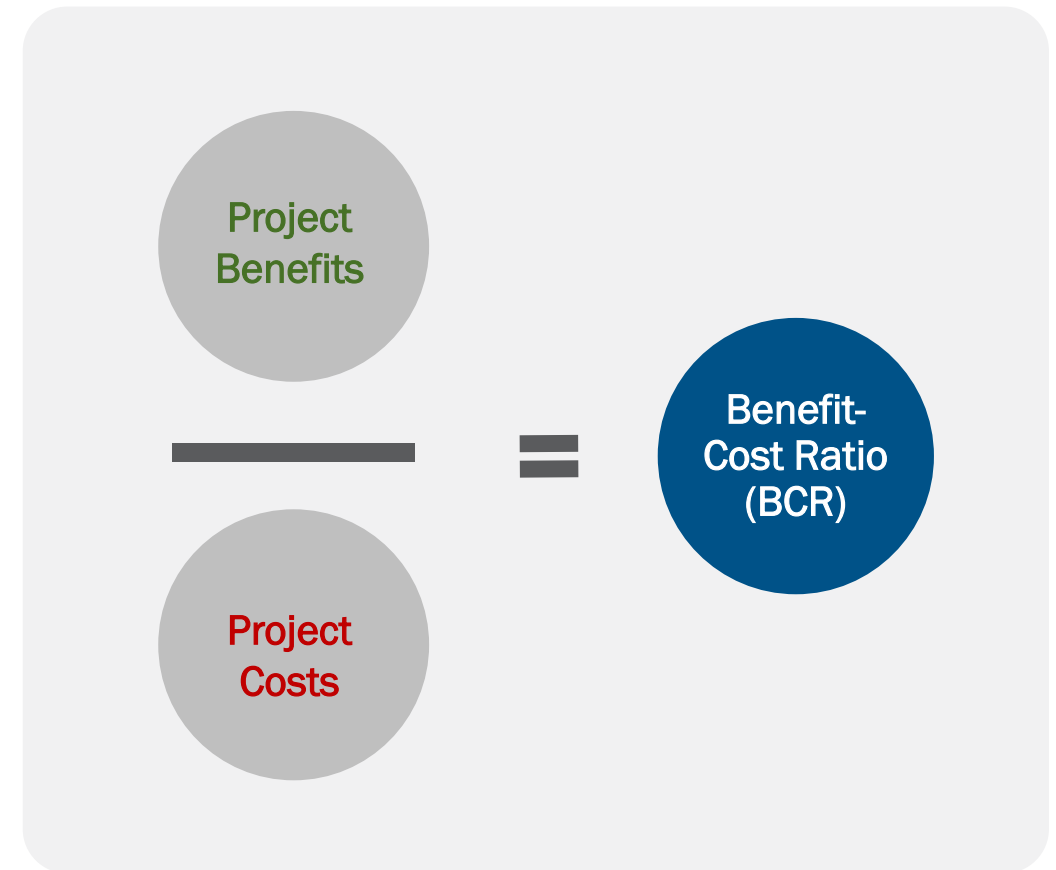


# Introduction

What is a BCA, and why is it needed?

# What is a BCA?

- A benefit-cost analysis (BCA) is the process of quantifying the benefits of an action versus the costs.
- A BCA can be conducted for a project to evaluate cost-effectiveness.
- A benefit-cost ratio (BCR) is a numerical expression of cost-effectiveness:
  - $BCR = (\text{Project Benefits})/(\text{Project Cost})$



## What is a BCA? (cont.)

- BCA compares before-mitigation conditions to after-mitigation conditions.
- BCA captures risk reduction in terms of losses avoided. Risk is the severity and likeliness of an event occurring.
- Losses are calculated based on the size (recurrence interval or frequency of the event) and are determined based on:
  - Historical costs/damages
  - Calculations from engineering analysis
  - Estimated losses
- If damages are reduced after mitigation is implemented, then there are benefits to count.
  - Benefits = future avoided losses
- If the benefits are greater than costs ( $BCR > 1.0$ ), the project is cost-effective.

### Before-Mitigation Scenario:



“What happens if the project is not implemented?”

A: Area continues to experience damages similar to the past.

### After-Mitigation Scenario:



“What happens if the project is implemented?”

A: Damages are expected to be reduced/eliminated depending on the project’s level of protection.



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# Why is a BCA Needed?

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- The purpose of a BCA is to determine whether a hazard mitigation project is an efficient use of FEMA Hazard Mitigation Assistance (HMA) funding.
  - To be eligible for HMA funding, FEMA requires hazard mitigation projects to have a BCR greater than 1.0.
  - Helps communities prioritize projects
- Statutory and regulatory drivers set the requirement to show cost-effectiveness.
  - Stafford Act
  - Title 44 Code of Federal Regulations
  - Office of Management and Budget Circular A-94



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# How do I Demonstrate Cost-Effectiveness?

## Established Precalculated Benefits (PCB) for Certain Project Types

- Does not require a BCA
  - Acquisitions and elevations in the Special Flood Hazard Area
  - Acquisitions of RL and SRL properties
  - Residential hurricane wind retrofits
  - Nonresidential hurricane wind retrofits
  - Individual tornado safe rooms
  - Post-wildfire mitigation
  - Hospital generators

Refer to PCB memoranda at:  
<https://www.fema.gov/grants/guidance-tools/benefit-cost-analysis>

## FEMA BCA Toolkit Version 6.0

*(Focus of This Presentation)*

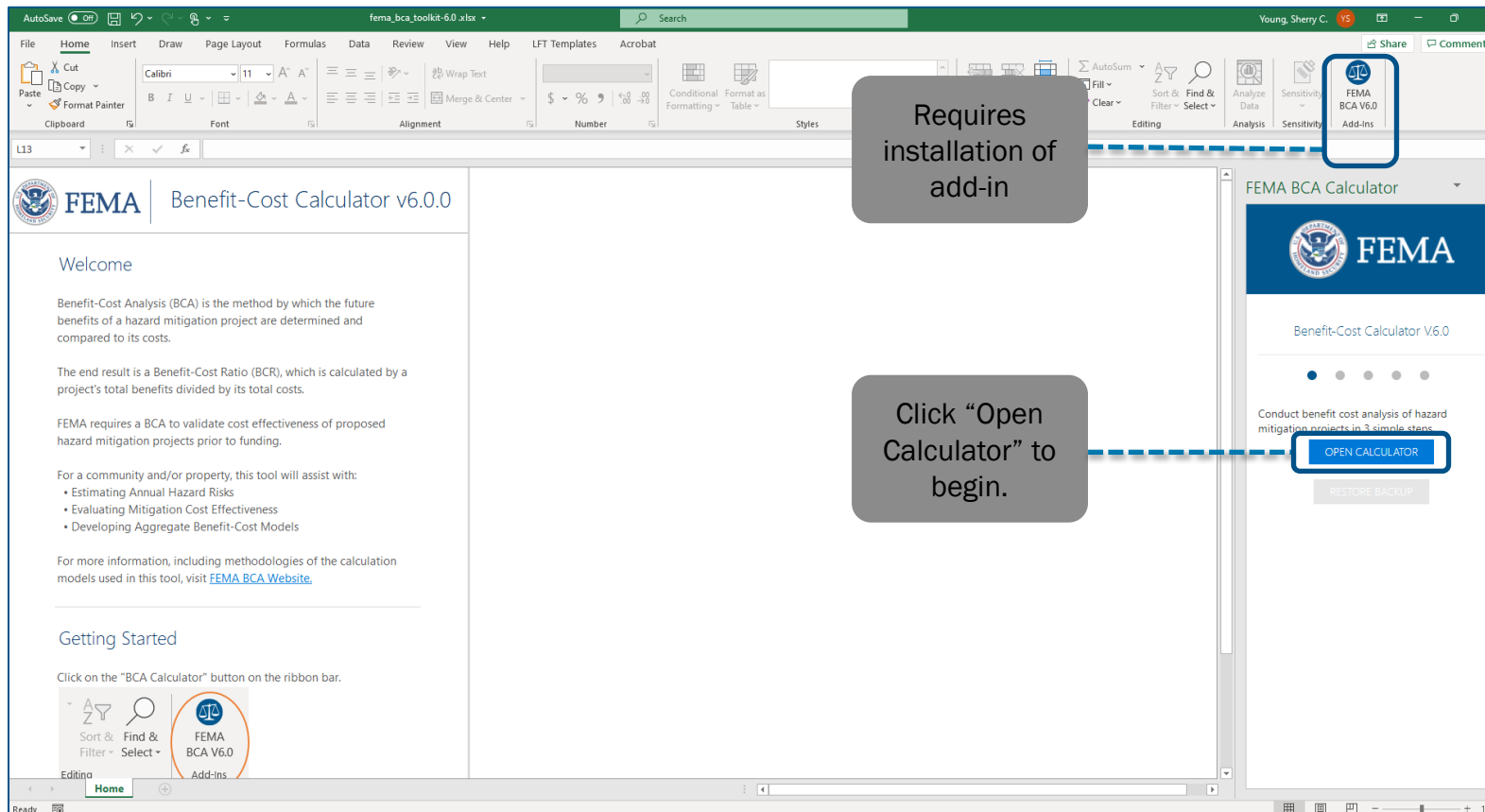
- Used if project does not qualify for PCB
- Developed in accordance with Circular A-94
- Excel-based calculator using FEMA-approved methodologies and tools
- Includes “modules” for various natural hazards
- Requires online connection and automatically updates



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# FEMA BCA Toolkit Version 6.0



Download BCA Toolkit Version 6.0 at:  
[https://www.fema.gov/sites/default/files/2020-04/fema\\_bca\\_toolkit-6.0.xlsx](https://www.fema.gov/sites/default/files/2020-04/fema_bca_toolkit-6.0.xlsx)

Toolkit Installation Instructions:  
<https://www.fema.gov/grants/guidance-tools/benefit-cost-analysis>



### Tip:

Try the **Excel online version** if experiencing difficulties running the toolkit on the Excel desktop version. The Excel online version is the same as the desktop version except for the way it is accessed.





# Components of a BCA

What kind of information do you need to complete a BCA?

# What minimum information do you need for a BCA?



What are the project costs?



What natural hazard is your project addressing?



How often does that hazard occur?



How long will your project be effective?



What damages does this hazard cause to the community?



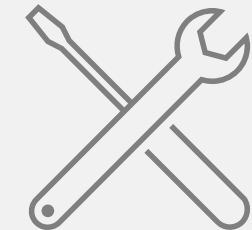
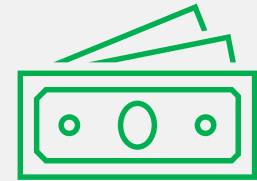
How much of this damage does your project prevent?





# What are the project costs?

- Initial project cost
  - All costs required for completing the mitigation project, regardless of who is paying for them.
- Annual maintenance cost
  - Costs needed for upkeep/repair of mitigation project components to keep project to desired level of effectiveness.
- Total mitigation project cost = initial project cost + annual maintenance costs
  - Future maintenance costs are discounted to present value.



# What natural hazard is your project addressing?



- Eligible mitigation projects must address one or more natural hazards.
  - Floods
  - Earthquakes
  - Wildfires
  - Hurricane winds
  - Tornados
  - Landslides

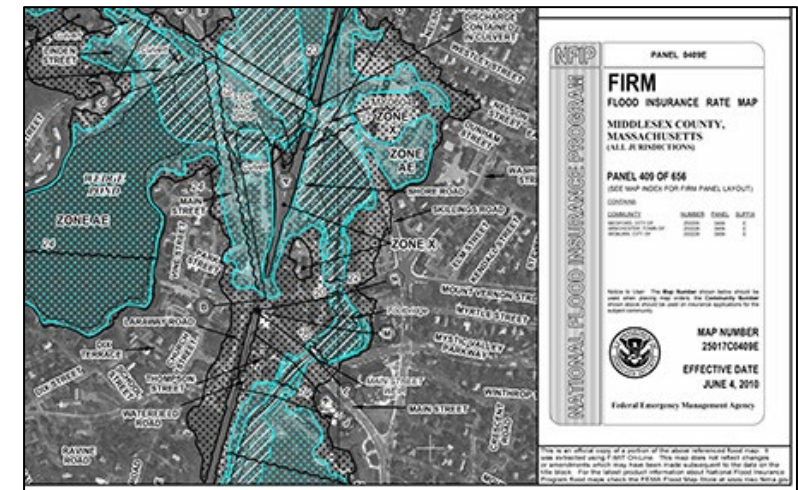


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# How often does that hazard occur?

- We cannot predict when a hazard will occur, but we can **estimate** how likely it is to occur based on historical events, hazard data, or specific hazard analyses (such as a hydrologic and hydraulic [H&H] study or fault rupture analysis).
- How often a hazard occurs is often represented by a recurrence interval (RI).
  - A RI is how often a hazard event of specific severity is likely to occur in a particular location.
  - Often expressed in years.
  - It is the inverse of the annual probability of an event.
  - Example:
    - RI of a flood is 100 years
    - Probability of occurring in any one year =  $1/100 = 0.01$
    - Annual probability = 1%



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# How long will your project be effective?



- Improvements to the built environment do not last forever.
  - Mitigation projects can only be relied upon to provide benefits for a finite amount of time.
- BCA Toolkit evaluates benefits over the project useful life (PUL).
- Project useful life = estimated amount of time (in years) that the mitigation action will be effective.
  - Depends on the project type.
  - Can be thought of as the “design life.”
  - FEMA has standard PULs for most project types.
  - Provide documentation if a nonstandard value is used.

FEMA Standard PULs

Acceptable Limits (Documentation Required)

PUL Summary Tables		
<i>Flood</i>		
Project Type	Useful Life	
	Standard Value	Acceptable Limits (documentation required)
<b>Acquisition / Relocation</b>		
Acquisition / Relocation	100	100
<b>Building Elevation</b>		
Residential Building	30	30-50
Non-Residential Building	25	25-50
Public Building	50	50-100
Historic Buildings	50	50-100
<b>Mitigation Reconstruction</b>		
Mitigation Reconstruction	50	50
<b>Infrastructure Projects</b>		
Major Infrastructure (dams, levees)	50	35-100
Concrete infrastructure, flood walls, roads, bridges, major drainage system	50	35-50



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# What damages does that hazard cause to the community? (1 of 7)



- What kind of losses would be avoided by completing the mitigation activity?
  - Benefits = future avoided losses
- Benefits can include:
  - Avoided physical damages
  - Avoided injuries/loss of life
  - Avoided loss of function
  - Social benefits (avoided mental stress and lost productivity)
  - Avoided emergency response costs
  - Avoided volunteer costs
  - Ecosystem services benefits (enhancing land use in a way that provides a higher level of natural ecosystem benefits)



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# What damages does that hazard cause to the community? (2 of 7)



- Physical damages
  - Damages to facilities requiring repair or replacement of structures, contents, roads/bridges, and/or utilities.
- Injuries/loss of life
  - Typically counted only for certain project types that address hazards where there is little or no warning time, or when emergency personnel must stay behind
  - Benefits depend on the affected building occupancy/population.



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# What damages does that hazard cause to the community? (3 of 7)



- Loss of function
  - Interruption to roads/bridges, utilities, residences, nonresidential buildings, and critical services because of a natural hazard event.
  - Benefits depend on value of the function and length of interruption.
  - Could also include “displacement” costs for buildings.
    - In other words, “displacement” costs = costs associated with temporary stay at another comparable location while repairs are made.



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# What damages does that hazard cause to the community? (4 of 7)



- Loss of function for roads/bridges
  - Benefits will depend on increased time and distance of detour needed when a road/bridge is lost and downtime length.
    - Provide estimated number of one-way traffic trips per day, additional time per one-way trip (minutes), number of additional miles.
    - BCA Toolkit provides standard value for mileage rate and delay time.
- Loss of function for utilities
  - Benefits calculated based on the value of service (\$/person/day), multiplied by the number of customers served and the duration of the loss of function.
  - BCA Toolkit provides standard values (\$/person/day) for electrical, potable water, and wastewater service.



# What damages does that hazard cause to the community? (5 of 7)



- Loss of function for critical facilities
  - Benefits based on mitigating loss of service by allowing police stations, fire stations, and hospitals to stay open or reduce their downtime.
  - BCA Toolkit determines value of service per day for police stations, fire stations, and hospitals based on specific inputs.
    - Fire station: Provide service population, type of area served (urban/suburban/rural/wilderness), distance to closest alternative station, and whether fire station provides emergency medical services.
    - Hospital: Provide service population, distance to alternative hospital, and service population of alternative hospital.
    - Police station: Provide type of area served (metro/city/rural), service population, number of police officers, and number of police officers that would serve the area if station were shut down because of a disaster.
- Loss of function for ordinary buildings (public/nonprofit sector buildings that provide a public service)
  - Based on the annual operating budget and duration of time the service is lost.



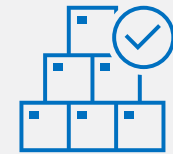
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# What damages does that hazard cause to the community? (6 of 7)



- Loss of function for residential buildings
  - Typically calculated as residential displacement costs.
  - Will depend on # occupants, building type, building replacement value, and duration of displacement.
  - BCA Toolkit provides default per diem values (lodging and meals) for project location.
  - Can also include loss of rental income (rental properties) or business income.
- Loss of function for nonresidential buildings
  - Typically calculated as nonresidential displacement costs.
  - Includes one-time displacements costs and monthly rental costs for comparable building.
  - Benefits will depend on occupancy class (building use) and duration of displacement.
  - Can also include loss of rental income (rental properties) or business income.



# What damages does that hazard cause to the community? (7 of 7)



- Ecosystem services benefits

- Applies to all types of mitigation projects that enhance land use in a way that provides a higher level of natural ecosystem benefits.
- Benefits will depend on project area being improved and the land use type(s) after the mitigation project is complete.



- Volunteer costs

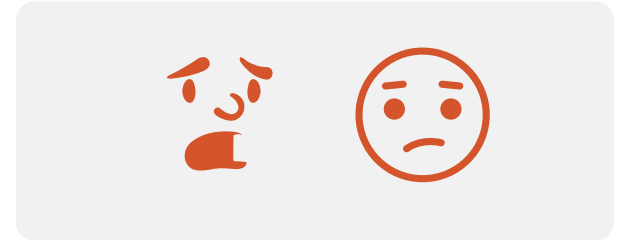
- Applicable when the project eliminates or reduces the need for volunteer labor.
- Benefits will depend on number of volunteers, number of days of lodging for volunteers, and lodging costs.



# What damages does that hazard cause to the community?



- Social benefits
  - Includes mental stress and anxiety and lost productivity benefits.
  - Applies to residential structures only.
  - Must have a BCR of  $>0.75$  to be applicable.
  - Based on residential building occupancy and number of residents that work.
  - BCA Toolkit provides mental stress and anxiety and lost productivity values (\$/person)
- Avoided emergency response costs
  - Costs include labor, equipment, and materials to perform emergency work.



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# How much of this damage does your project prevent?



- To what extent will the project reduce/eliminate physical damages, injuries/loss of life, loss of function, mental stress/anxiety, etc.?
- Project level of protection = design level or standard to which the project will be designed to avoid future losses.
- Most projects do not eliminate all risk.
  - Residual damages are present even after the project is implemented.
  - Exception: Acquisition projects remove structures from the floodplain and therefore fully eliminate flood risk.



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# Documenting the BCA for all projects

What documentation do you need for the BCA and what are some potential sources?



## Best Practices for All Projects

- Provide BCA files (export + pdf), BCA narrative, and all supporting attachments.
- Use data from credible and reliable sources (e.g., federal, state, local agencies).
- Provide copies of reports, data, and any other technical support information (copy of Flood Insurance Rate Map, Flood Insurance Study, reports from agencies, etc.).
- Clearly indicate project's level of protection.
- Provide justification for all inputs that are not FEMA standard/default values.

## Best Practices for All Projects (cont.)

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- Cite references and locations of relevant data to support BCA inputs.
- Organize data via list of attachments/subfolders.
- Perform initial BCA analysis with readily available data to determine status of BCR.
  - Assess whether additional benefits are necessary to show cost-effectiveness.
  - If project is cost-effective with readily available data, it may not be necessary to gather documentation to support additional benefit categories.
    - Example: For many nature-based solutions projects, ecosystem services benefits alone may be sufficient to get the project to a  $BCR > 1.0$ .



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# Basic Documentation Needed for All Projects (1 of 3)

BCA Input	What is it?	Where do you get it?
<b>Property location</b>	Address and/or latitude and longitude for each project structure	<ul style="list-style-type: none"> <li>• Documents available from homeowners, local building inspector, local tax assessor's office, title documents</li> <li>• Publicly available online mapping services</li> </ul>
<b>Property structure type</b>	Description of whether structure is residential, nonresidential, critical facility building, utility, road/bridge, etc.	<ul style="list-style-type: none"> <li>• Photos of property</li> <li>• Scope of work description</li> <li>• Information from project manager, project engineer, or other representative familiar with proposed project</li> </ul>
<b>Hazard type</b>	Description of the natural hazard the project intends to address	<ul style="list-style-type: none"> <li>• Scope of work description</li> <li>• Historical accounts of past damages and hazards causing them</li> <li>• Information from project manager, project engineer, or other representative familiar with proposed project</li> </ul>
<b>Mitigation action type</b>	Describes the specific mitigation project being considered; for example, an elevation or acquisition project	<ul style="list-style-type: none"> <li>• Scope of work description</li> <li>• Information from project manager, project engineer, or other representative familiar with proposed project</li> <li>• BCA Help Menu has detailed mitigation action type descriptions</li> </ul>



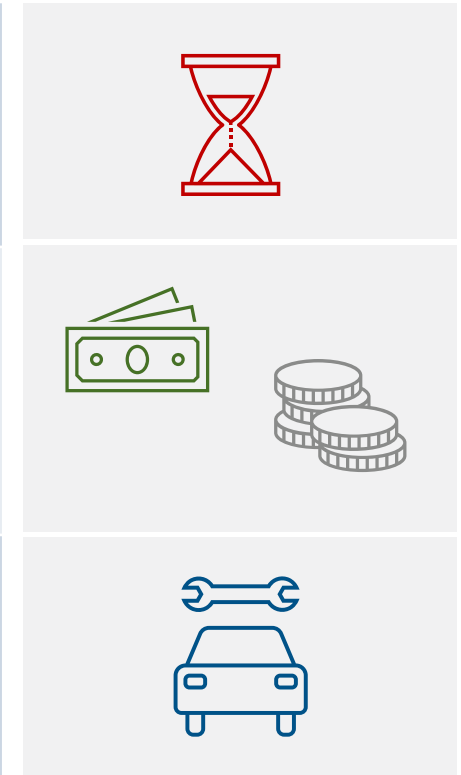
## Basic Documentation Needed for All Projects (2 of 3)

BCA Input	What is it?	Where do you get it?
<b>Damage frequency relationship</b>	Describes whether the BCA will be completed using modeled damages, historical damages, or professional expected damages	<ul style="list-style-type: none"><li>Information from project manager, project engineer, or other representative familiar with proposed project and expected damages</li><li>Damage frequency relationship will depend on several factors:<ul style="list-style-type: none"><li><b>Modeled damages:</b> Use this option to perform the BCA analysis on the property, regardless of past damage history. BCA results for the selected hazard will be modeled based on inputs provided.</li><li><b>Historical damages:</b> Use this option if there is insufficient data to use Modeled Damages, if property structure type is not a building, or if primary data are historic damages.</li><li><b>Professional expected damages:</b> Use this option when a project official can reasonably estimate the frequency and severity of damage (such as physical damages, loss of function, etc.) to impacted entities both before-mitigation and after-mitigation.</li></ul></li></ul>



# Basic Documentation Needed for All Projects (3 of 3)

BCA Input	What is it?	Where do you get it?
<b>Project useful life (PUL)</b>	Estimated amount of time (years) that the mitigation action will be effective	<ul style="list-style-type: none"> <li>• BCA Help Menu provides a PUL table for most project types.</li> <li>• If standard values are not used, additional documentation is needed (such as a letter from the project manager, project engineer, etc. or manufacturer’s specifications, or other credible source).</li> </ul>
<b>Initial project cost</b>	All costs required for completing the mitigation project	<ul style="list-style-type: none"> <li>• Estimate from contractor or project engineer</li> <li>• Line-item cost estimate based on standard cost estimating software or local similar historical costs in present day dollars.</li> <li>• Source should be subapplicant or professional with relevant expertise.</li> </ul>
<b>Annual maintenance cost</b>	Costs needed for upkeep/repair of project components to keep project to desired level of effectiveness	<ul style="list-style-type: none"> <li>• Estimates can be provided by standard cost estimating software, contractors, engineering documents, or documentation from a reliable source such as a professional with relevant expertise.</li> </ul>





# Tips to Improve the BCA and Improve the BCR

- If the BCA is not cost-effective, how can benefits be increased to improve the BCR?
  - Increase the number of scenario events used in the BCA.
    - The more scenario events that are included, the more benefits will be calculated.
  - Determine if there are more frequent (smaller events) that would impact the project area.
    - While a larger event may cause greater damages, smaller events with less damages happen more frequently.
  - Determine if additional benefits can be included in the BCA.
    - Think about additional benefit categories that may have been missed.
  - Ensure the most recent data is included in the BCA.
    - Site conditions may have changed, or there may be a more recent study with updated data.



# Resources to Help with BCA

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- FEMA BCA Website:
  - <https://www.fema.gov/grants/guidance-tools/benefit-cost-analysis>
- BCA Reference Guide:
  - [https://www.fema.gov/sites/default/files/2020-04/fema\\_bca\\_reference-guide.pdf](https://www.fema.gov/sites/default/files/2020-04/fema_bca_reference-guide.pdf)
- Supplement to the BCA Reference Guide:
  - [https://www.fema.gov/sites/default/files/2020-08/fema\\_bca\\_guide-supplement.pdf](https://www.fema.gov/sites/default/files/2020-08/fema_bca_guide-supplement.pdf)
- FEMA's BCA Helpline:
  - Email: [bchelpline@fema.dhs.gov](mailto:bchelpline@fema.dhs.gov)
  - Phone: 1-855-540-6744



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Thank You



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